REFRACTIVE INDEX OF VARIOUS ALKALI CHLORIDE AT DIFFERENT MOLAL CONCENTRATION AND THEIR COMPARISON

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ABSTRACT

Refractive index of HCl, NaCl and KCl solution of different molal concentration were obtained at room temperature. It was found that refractive index of one molal KCl solution was more than refractive index of one molal NaCl solution. It was also observed that refractive index of one molal NaCl solution was more than refractive index of one molal HCl solution. Such relation was observed at two, three, four and five molal concentration too. This increase of refractive index of alkali chloride is observed as we go down the periodic table of group one (alkali element). This is due to increase in density of solution as we go down the periodic table at particular molal concentration.

KEYWORDS: *Refractive index, NaCl, HCl, KCl, Alkali Halide*

INTRODUCTION

At room temperature using Spectrometer, hollow glass prism and Sodium source as a monochromatic light source refractive index of KCl, NaCl and HCl solution was obtained at different molal concentration. It was observed that Refractive index of KCl solution was greater than Refractive index of NaCl solution and refractive index of NaCl solution was greater than refractive index of HCl at different concentration. Molecular weight of KCl is 74.55gm [2]. Thus 74.55gm KCl was dissolved in 1000 ml of water to form one molal KCl solution [3]. Similarly, 58.44gm and 36.45gm of NaCl and HCl were dissolved in 1000ml of water to form one molal NaCl and one molal HCl solution respectively [4][5]. As mass required to form one molal KCl solution was more as compared to one molal NaCl and HCl solution thus the density of one molal KCl solution is more than one molal NaCl and HCl solution [6]. Due to this refractive index of KCl is more than refractive index of NaCl and HCl at every molal concentration [1].

EXPERIMENT

Refractive index of KCl, NaCl and HCl solution of different molal concentration were prepared at room temperature. Telescope, Prism table and collimator were aligned horizontally using spirit level. Hollow glass prism filled with one molal HCl solution was placed on prism table with its base parallel to telescope and collimator. Angle of minimum deviation was obtained using Shuster's method [7]. This procedure was repeated five times to reduce error and to calculate mean of angle of minimum deviation ∫m. With angle of prism A= 60° the prism formula

$$\mu = \frac{\mathrm{Sin}\{[A + \int m]/2\}}{\mathrm{Sin}[A/2]} \quad [8]$$

Reduces to equation μ = 2*Sin[(60+∫m)/2]…….. (1) Where μ is the refractive index of desired medium. By using Equation (1) refractive index of one molal HCl solution was obtained. A similar procedure was repeated for 2, 3, 4 and 5 molal HCl, KCl and NaCl solution. Graph of refractive index of all solution against molal concentration was plotted on same graph. Observation table to compute refractive index of different medium are given below.

1] One molal NaCl solution

Sr	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	162°33'	342°16'	138°17'	317°59'	24°16'	24°17'	24°16'
2	148°59'	328°36'	125°	304°42'	23°59'	23°54'	23°56'
3	135°27'	315°05'	111°28'	291°09'	23°59'	33°56'	23°57'
4	122°48'	302°34'	98°45'	278°30'	24°03'	24°04'	24°03'
5	110°04'	289°57'	85°21'	265°06'	24°43'	24°51'	24°47'

Thus ∫m= 24°11'

μ = 2*sin[(60+∫m)/2]

μ = 1.3406

Hence refractive index of 1 molal NaCl solution at room temperature is 1.3406

2] Two molal NaCl solution

Sr	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	94°57'	274°44'	69°55'	249°45'	25°02'	24°49'	24°55'
2	81°30'	261°22'	56°40'	236°05'	24°50'	25°17'	25°03'
3	66°50'	246°40'	41°47'	221°44'	25°03'	24°56'	24°59'
4	51°08'	231°13'	26°35'	206°37'	24°33'	24°36'	24°34'30''
5	38°39'	218°43'	14°02'	194°12'	24°37'	24°31'	24°34'

Thus ∫m= 24°49'06"

μ = 2*sin[(60+∫m)/2]

μ = 1.3488

Hence refractive index of 2 molal NaCl solution at room temperature is 1.3488

3] Three molal NaCl solution

Sr	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	25°341'	205°46'	0°5'	180°18'	25°36'	25°28'	25°32'
2	11°30'	191°39'	345°53'	166°09'	25°37'	25°30'	25°33'
3	357°30'	177°42'	331°59'	152°11'	25°31'	25°31'	25°31'
4	344°05'	164°27'	318°30'	139°	25°35'	25°27'	25°31'
5	326°12'	146°33'	300°36'	121°	25°36'	25°33'	25°34'

Thus ∫m= 25°32'

μ = 2*sin[(60+∫m)/2]

μ = 1.3580

Hence refractive index of 3 molal NaCl solution at room temperature is 1.3580

4] Four Molal NaCl solution

Sr	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	310°28'	130°46'	284°36'	104°59'	25°52'	25°47'	25°49'
2	297°20'	117°36'	271°38'	91°49'	25°42'	25°47'	25°44'
3	282°23'	102°38'	256°15'	76°24'	26°08'	26°14'	26°11'
4	268°26'	88°33'	62°28'	242°18'	26°08'	26°05'	26°06'
5	254°53'	75°	228°43'	48°48'	26°10'	26°12'	26°11'

∫m = 26°0'

μ = 2Sin[(A+∫m)/2] = 1.3640

Hence refractive index of 4 molal NaCl solution at room temperature is 1.3640

5] Five molal NaCl solution

Sr	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	154°44'	334°28'	128°30'	308°06'	26°14'	26°22'	26°17'
2	140°48'	320°30'	113°48'	293°35'	27°	26°55'	26°57'30''
3	124°52'	304°37'	98°41'	277°58'	26°11'	26°39'	26°25'
4	110°52'	290°05'	83°39'	263°23'	27°13'	26°42'	26°57'30''
5	96°06'	275°56'	69°50'	249°41'	26°16'	26°15'	26°15'30''

∫m = 26°34'

μ = 2Sin[(A+∫m)/2] = 1.3712

Hence refractive index of 5 molal NaCl solution at room temperature is 1.3712

6] One Molal KCl solution

Sr.	∫m position		Direct reading		difference		mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	154°47'	334°04'	130°45'	310°34'	24°02'	23°30'	23°46'
2	142°56'	322°43'	118°18'	298°06'	24°38'	24°37'	24°37'30''
3	128°48'	308°39'	104°28'	284°16'	24°20'	24°23'	24°21'30''
4	117°06'	296°52'	92°41'	272°32'	24°25'	24°20'	24°22'30''
5	103°53'	283°42'	79°55'	254°45'	23°58'	23°57'	23°57'30''

∫m = 24°13'

μ = 2Sin[(A+∫m)/2]

μ = 1.3410

Hence refractive index of 1 molal KCl solution at room temperature is 1.3410

7] Two Molal KCl solution

Sr.	∫m position		Direct reading		difference		mean
	A'	**B'**	**A**	**B**	**A'-A**	**B'-B**	**∫m**
1	94°57'	274°44'	69°55'	249°45'	25°02'	24°49'	24°55'
2	81°30'	261°22'	56°40'	236°05'	24°50'	25°17'	25°03'
3	66°50'	246°40'	41°47'	121°44'	25°03'	24°56'	24°59'
4	51°08'	231°13'	26°35'	206°37'	24°33'	24°36'	24°34'30''
5	30°39'	318°43'	14°02'	194°12'	24°37'	24°31'	24°34'

∫m = 25°05'

μ = 2Sin[(A+∫m)/2]

μ = 1.3522

Hence refractive index of 2 molal KCl solution at room temperature is 1.3522

8] Three molal KCl solution

Sr.	∫m position		Direct reading		difference		mean
	A'	**B'**	**A**	**B**	**A'-A**	**B'-B**	**∫m**
1	21°5'	192°25'	346°36'	166°47'	25°39'	25°38'	25°38'30''
2	0°	180°15'	234°24'	154°40'	25°36'	25°35'	25°35'30''
3	347°51'	168°09'	322°11'	142°32'	25°40'	25°37'	25°38'30''
4	334°09'	154°26'	308°33'	128°54'	25°36'	25°32'	25°34'

∫m = 25°36'30"

μ = 2Sin[(A+∫m)/2]

μ = 1.3589

Hence refractive index of 3 molal KCl solution at room temperature is 1.3589

9] Four molal KCl solution

Sr.	∫m position		Direct reading		difference		mean
	A'	**B'**	**A**	**B**	**A'-A**	**B'-B**	**∫m**
1	125°28'	305°07'	99°26'	279°06'	26°02'	26°01'	26°01'30''
2	109°22'	289°10'	83°34'	263°12'	25°48'	25°58'	25°53'
3	94°54'	274°36'	69°08'	248°58'	25°46'	25°38'	25°42'
4	85°20'	265°15'	59°33'	239°24'	25°47'	25°51'	25°49'
5	67°54'	247°49'	41°66'	221°18'	26°38'	26°31'	26°34'30''

∫m = 26°

μ = 2Sin[(A+∫m)/2]

μ = 1.3639

Hence refractive index of 4 molal KCl solution at room temperature is 1.3639

10] One molal HCl solution

Sr.	∫m position		Direct reading		difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	239°14'	59°20'	215°40'	35°41'	23°34'	23°39'	23°36'30''
2	226°04'	46°	2°31'	22°23'	23°33'	23°37'	23°35'
3	212°51'	32°47'	189°20'	9°12'	23°31'	23°35'	23°33'
4	201°30'	21°26'	178°	357°53'	23°30'	23°33'	23°31'30''
5	188°52'	8°41'	165°22'	345°07'	23°30'	23°34'	23°32'

∫m = 23°33'36"

μ = 2Sin[(A+∫m)/2]

μ = 1.3325

Hence refractive index of 1 molal HCl solution at room temperature is 1.3325

11] Two Molal HCl solution

Sr.	∫m position		Direct reading		difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	218°26'	38°24'	194°38'	14°35'	23°48'	23°49'	23°48'30"
2	204°48'	24°40'	181°04'	0°59'	23°44'	23°41'	23°42'30"
3	191°22'	11°15'	167°36'	347°25'	23°46'	23°50'	23°48'
4	177°57'	357°46'	154°10'	333°56'	23°47'	23°50'	23°48'30"
5	164°45'	844°3'	141°02'	320°44'	23°43'	23°47'	23°45'

∫m = 23°46'30"

μ = 2Sin[(A+∫m)/2]

μ = 1.3353

Hence refractive index of 2 molal HCl solution at room temperature is 1.3353

12] Three Molal HCl solution

Sr.	∫m position		Direct reading		difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	105°07'	284°55'	81°08'	260°56'	23°59'	23°59'	23°59'
2	91°	270°54'	67°	246°53'	24°	24°01'	24°0'30"
3	76°48'	256°42'	52°48'	232°42'	24°	24°	24°
4	25°59'	206°04'	1°58'	182°07'	24°01'	23°57'	23°59'
5	11°36'	191°48'	347°36'	167°52'	24°	23°56'	23°58'

∫m = 23°59'18"

μ = 2Sin[(A+∫m)/2]

μ = 1.3381

Hence refractive index of 3 molal HCl solution at room temperature is 1.3381

13] Four molal HCl solution

Sr.	∫m position		Direct reading		difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	358°10'	178°25'	333°40'	153°58'	24°30'	24°27'	27°28'30"
2	345°	165°18'	320°30'	140°54'	24°30'	24°24'	24°27'
3	330°51'	151°07'	306°43'	127°06'	24°08'	24°01'	24°4'30"
4	316°43'	337°03'	291°56'	112°17'	24°47'	24°46'	24°46'30"
5	302°	122°18'	277°26'	97°42'	24°34'	24°36'	24°35'

∫m = 24°28'18"

μ   = 2Sin[(A+∫m)/2]

μ   = 1.3443

Hence refractive index of 4 molal HCl solution at room temperature is 1.3443

14] Five Molal HCl solution

Sr.	∫m position		Direct reading		difference		Mean
	A'	B'	A	B	A'-A	B'-B	∫m
1	288°35'	108°45'	263°36'	83°45'	24°49'	25°	24°54'30"
2	274°45'	94°56'	249°46'	69°54'	24°59'	25°02'	25°0'30"
3	261°10'	81°17'	236°32'	56°34'	24°38'	24°43'	24°40'30"
4	246°56'	67°	222°15'	42°18'	24°41'	24°42'	24°41'30"
5	232°09'	52°12'	207°36'	27°31'	24°33'	24°41'	24°37'

∫m = 24°46'

μ   = 2Sin[(A+∫m)/2]

μ   = 1.3481

Hence refractive index of 5 molal HCl solution at room temperature is 1.3481

RESULTS AND DISCUSSIONS

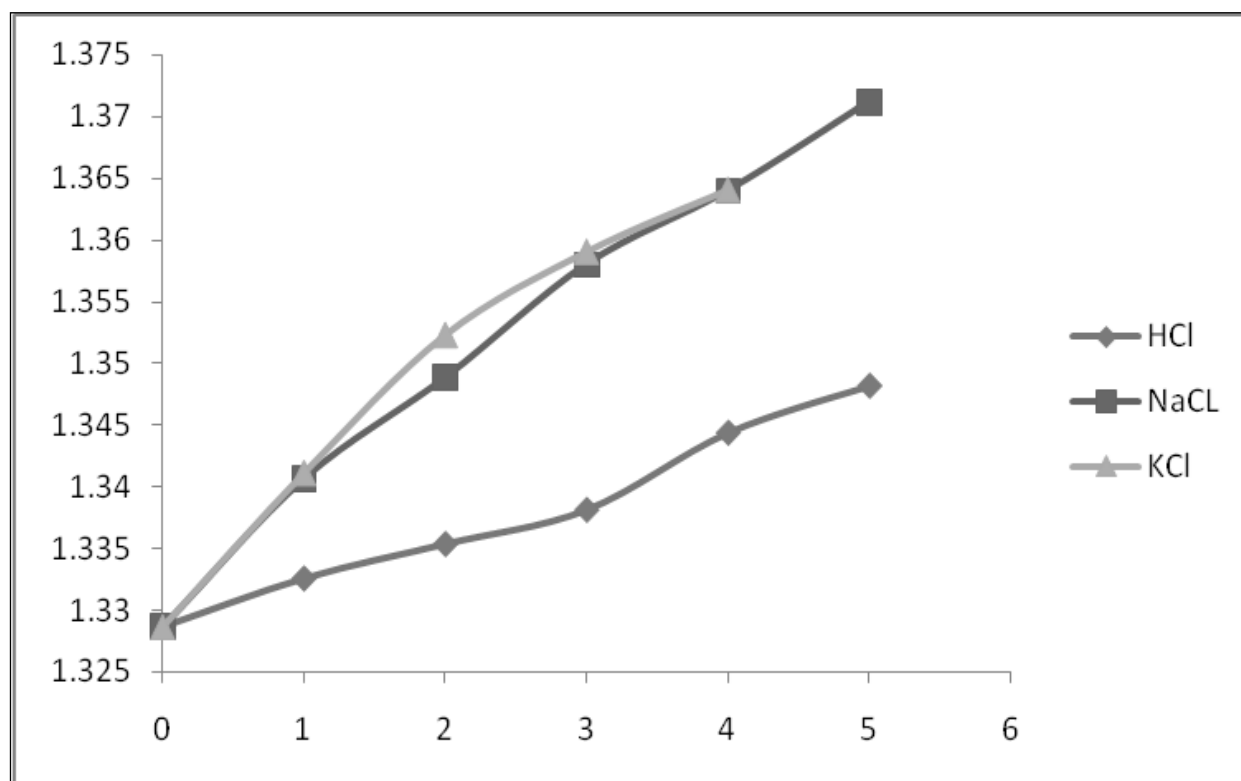**Figure 1: Graph of Refractive Index of KCl, NaCl and HCl against Molal Concentration**

From graph, it is clearly seen that Refractive index of KCl >NaCl>HCl solution at 1, 2, 3 and 4 molal concentration. This was true as one molal KCl solution has more density than one molal NaCl or HCl solution. It was also observed that refractive index of HCl, NaCl and KCl solution increases individually with increase in molal concentration using hollow glass prism [9][10]. Due to lack of availability of Li the LiCl was not taken into consideration. Curve of LiCl may be predicted between curve of HCl and NaCl.

CONCLUSIONS

Refractive index of alkali halide was found to be increased as we choose alkali element down the periodic table at 1, 2, 3 and 4 molal concentration. Refractive index of 5 molal NaCl solution was greater than refractive index of 5 molal HCl solution.

FUTURE SCOPE: Such conclusion can be verified for different combinations of elements of periodic table.

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